

1 TITLE OF THE INVENTION

2 REAR GATE OPENING AND CLOSING APPARATUS FOR VEHICLE

3

4 BACKGROUND OF THE INVENTION

5 1. Field of the invention

6 The present invention relates to a vehicular rear gate  
7 opening and closing apparatus whose upper end is pivotally  
8 connected with a vehicle body so as to swing up and down and more  
9 particularly to a rear gate capable of opening and closing in  
10 two ways by an actuator or by hand.

11 2. Discussion of prior art

12 *Sub 957* As shown in Fig. 12, generally a rear gate 102 disposed  
13 in the rear of a vehicle is a lid swinging up and down for opening  
14 and closing an opening 101. The rear gate 102 is at the upper  
15 end thereof secured to a hinge arm 103 rotatably supported by  
16 an upper edge of the opening 101 of a vehicle body 100.

17 A gas stay 105 is connected between a side edge of the  
18 rear gate 102 and a side edge 104a of the opening 101 formed along  
19 a rear pillar 104. The gas stay 105 has a piston rod 105a biased  
20 in an axial (longitudinal) direction by sealed gas pressure. When  
21 the rear gate 102 opens or closes, the gas stay 105 expands or  
22 contracts according to an opening or closing angle of the rear  
23 gate 102 and the biasing force applies an assist force to the  
24 piston rod 105a, thereby an opening or closing effort of the rear  
25 gate 102 can be reduced.

Sub.  
D2

09755564-010301

1 According to a rear gate opening and closing mechanism  
2 disclosed in Japanese Patent Application Laid-open No. Toku-  
3 Kai-Hei 5-280242 and also shown in Fig. 13, the rear gate 112  
4 has a hinge arm 113 at the upper end thereof and the hinge arm  
5 113 is pivotally supported by a vehicle body 110. The hinge arm  
6 113 has a curved section 114 formed in such a manner as extending  
7 forwardly from a pivoting point P of the hinge arm 113, making  
8 a U-turn and then extending backwardly. The curved section 114  
9 communicates with a rear gate fitting section 115 to which the  
10 rear gate 112 is secured. A rod 116 is pivotally connected at  
11 a boss section 117 provided at the rear end thereof with a slightly  
12 lower part of the curved section 114 than the pivoting point P.  
13 A front end of the rod 116 is slidably fitted to a supporting  
14 hole 118 and a coil spring 119 is interposed between a rear spacer  
15 120 and the boss section 117.

Sub  
a47

16 According to the rear gate structure shown in Fig. 12,  
17 the gas stay 105 laid between the rear gate 102 and the side edge  
18 104a provides an assist force when the rear gate 102 operates  
19 to open or close and as a result the operating effort of the rear  
20 gate 102 can be reduced.

Sub  
a77

21 Referring to Fig. 13, when the rear gate 112 is swings  
22 upward, the hinge arm 113 rotates integrally with the rear gate  
23 112 around the pivoting point P. Then, since the coil spring 119  
24 pushes the curved section 114, a rotating force is applied to  
25 the hinge arm 113, thereby the operating effort when opening the

1 rear gate 112 can be reduced.

2           However, there is a fear that the gas stay 105 which  
3 is provided between the rear gate 102 and the side edge 104a  
4 hinders loading or unloading works through the opening 101.  
5 Further, since the gas stay 105 is exposed to the compartment,  
6 there is a problem that the interior space is limited as much  
7 and also there is an aesthetic problem. To solve these problems,  
8 one idea is to accommodate the gas stay between the rear gate  
9 102 and the side edge 104a of the opening 101. Since the diameter  
10 of the gas stay is determined by gas pressure for supporting the  
11 weight of the rear gate, the thickness of the pillar in which  
12 the gas stay is housed is dependant upon the rear gate. Further,  
13 since the stroke of the gas stay is determined by the specification  
14 of the rear gate, the straight portion of the rear pillar for  
15 accommodating the gas stay has an effect on the styling of the  
16 rear pillar itself. That is, the freedom of the rear design of  
17 the vehicle is restricted.

18           According to the rear gate structure disclosed by  
19 Toku-Kai-Hei 5-280242, when the rear gate 112 swings upward to  
20 open, the curved section 114 of the hinge arm 113 is pushed by  
21 the coil spring 119. As a result, the hinge arm 113 has a rotating  
22 force to reduce the operating effort of an operator. Further,  
23 since the gas stay is not disposed between the side edge of the  
24 opening and the rear gate 112, the freedom of designing of the  
25 rear pillar, the rear gate 112 and the like is enlarged.

09755554-1925/60  
1 On the other hand, the rear gate structure according  
2 to Toku-Kai-Hei 5-280242 is designed so as to open and close by  
3 rifting up or pushing down an outer handle of the rear gate by  
4 hand from outside of the vehicle. The opening and closing effort  
5 of the rear gate is generally troublesome to the operator and  
6 particularly, when it rains heavily and his or her hands are full  
7 with baggage, it is desirable that an opening and closing  
8 apparatus for automatically opening and closing the rear gate  
9 can be operated by the operator while he or she stays in the  
10 passenger compartment.

#### 11 12 SUMMARY OF THE INVENTION

13 It is a first object of the present invention to provide  
14 a compact rear gate opening and closing apparatus capable of  
15 automatically opening and closing a rear gate without hindering  
16 an interior space of the passenger compartment. It is a second  
17 object of the present invention to provide a rear gate opening  
18 and closing apparatus capable of opening and closing the rear  
19 gate not only automatically but also by hand. It is a third object  
20 of the present invention to provide a rear gate opening and closing  
21 apparatus capable of properly regulating the opening and closing  
22 speed.

23 In order to achieve the first object, the rear gate  
24 opening and closing apparatus comprises a power source means for  
25 producing a power to actuate the rear gate, a slider for

057525250  
1 transforming the power into a reciprocating motion and traveling  
2 in the longitudinal direction of a vehicle, a hinge arm provided  
3 at the upper end of the rear gate for pivotally connected with  
4 the vehicle body, a connecting rod for interlocking between the  
5 slider and the hinge arm and for transmitting the reciprocating  
6 motion to the hinge arm, a mounting base for supporting the power  
7 source means and the slider, a mounting base installing means  
8 for detachably installing the mounting base in a space formed  
9 by a rear rail, a side rail and an under roof of the vehicle,  
10 and a gas stay extending in the longitudinal direction of the  
11 vehicle, provided between the side rail and the hinge arm and  
12 disposed at approximately the same height as and in parallel with  
13 the connecting rod for biasing the rear gate in an opening  
14 direction.

15 To attain the second object of the present invention,  
16 The rear gate opening and closing apparatus comprise a clutch  
17 means for disconnecting the power source means with the slider  
18 so as to enable an operator to open or close the rear gate by  
19 hand.

20 Further, to attain the third object, the rear gate  
21 opening and closing apparatus comprises a position detecting  
22 means for detecting a position of the rear gate and for outputting  
23 a detection signal thereof, an operating means for operating an  
24 opening and closing motion of the rear gate and a control means  
25 for automatically opening and closing the rear gate based on an

1 operating signal from the operating means and the detection signal  
2 from the position detecting means.

3

#### 4 BRIEF DESCRIPTION OF THE DRAWINGS

5 Fig. 1 is a perspective rear view showing a vehicle  
6 having a rear gate opening and closing apparatus according to  
7 the present invention;

8 Fig. 2 is a plan view showing a drive unit of a rear  
9 gate opening and closing mechanism according to a first embodiment  
10 of the present invention;

11 Fig. 3 is a side view showing a drive unit of a rear  
12 gate opening and closing mechanism according to the present  
13 invention;

14 Fig. 4 is an exploded view of a drive unit of a rear  
15 gate opening and closing apparatus according to the present  
16 invention;

17 Fig. 5 is a sectional view taken along a line I-I of  
18 Fig. 2;

19 Fig. 6 is a sectional view taken along a line II-II  
20 of Fig. 2;

21 Fig. 7 is a sectional view taken along a line III-  
22 III of Fig. 2;

23 Fig. 8 is a plan view showing a drive unit of a rear  
24 gate opening and closing mechanism according to a second  
25 embodiment of the present invention;

1 Fig. 9 is a block diagram of a control apparatus of  
2 a rear gate opening and closing apparatus according to a second  
3 embodiment of the present invention;

4 Fig. 10 is an explanatory view showing a control  
5 strategy of a rear gate opening and closing apparatus;

6 Fig. 11 is a perspective rear view of a vehicle having  
7 a rear gate structure according to a prior art; and

8 Fig. 12 is a side view showing a rear gate structure  
9 according to a prior art.

10  
11 DESCRIPTION OF THE PREFERRED EMBODIMENTS

12 The present invention will be described more in detail  
13 by reference to the accompanying drawings.

14 Referring now to Fig. 1, a vehicle body 10 is provided  
15 with a rear opening 13 having a side edge 13a at each side of  
16 the body 10 and an upper edge 13b. A roof 12 is connected at the  
17 rear end thereof with a rear gate 20 for pivotally opening and  
18 closing the opening 13 through a hinge arm 23. The rear gate 20  
19 is rotatably swung up and down by an opening and closing apparatus  
20 30.

21 The opening and closing apparatus 30, especially the  
22 hinge arm 23 and the drive unit 31, will be described by reference  
23 to Figs. 2 to 7. In the drawings, an arrow-marked "F" denotes  
24 a front direction of the vehicle, an arrow-marked "IN" denotes  
25 an inner direction of the vehicle and an arrow-marked "OUT"

1 denotes an outer direction of the vehicle.

2 Fig. 2 shows a drive unit of a rear gate opening and  
3 closing mechanism according to a first embodiment of the present  
4 invention and Fig. 3 shows a drive unit of the rear gate opening  
5 and closing mechanism. In Figs. 2 and 3, the vehicle body 10 and  
6 the rear gate 20 are shown by two-dots chain lines.

7 The hinge arm 23 is rotatably supported at the end boss  
8 23a thereof by a pivot 22 secured to an hinge base 21 which is  
9 attached to the neighborhood of the rear end of a roof 12.  
10 Describing the state where the rear gate 20 is closed, the hinge  
11 arm 23 extending downwardly and forwardly from the end boss 23a,  
12 forms a bent section 24. The bent section 24 extends backwardly  
13 being bent in a circle around the pivot 22, penetrates through  
14 a hinge arm penetrating hole 23A provided in a rear rail 14 and  
15 projects the rear end thereof outside. The rear end has a rear  
16 gate mounting bracket 25 for mounting the rear gate 20 and the  
17 front end of the bent section 24 has a connecting rod connection  
18 section 26 and a gas stay connection section 27.

19 *Sub* The opening and closing apparatus 30 has the drive unit  
20 *987* 31 and a gas spring apparatus 50 for assisting the operation of  
21 the drive unit 31. As shown in Figs 2 and 4, the drive unit 31  
22 is provided with a mounting base 32 having a base plate 32A with  
23 a slot 32a longitudinally shaped, a rear flange 32b and a side  
24 flange 32c for reinforcing the base plate 32A.

25 Further, a power unit module 40 as shown in Fig. 4 is

1 mounted on the top surface of the base plate 32A of the mounting  
2 base 32.

3 The power unit module 40 includes a motor 41 operative  
4 forwardly and reversely and a gear box (not shown) for converting  
5 the rotating motion of the motor into the reciprocating motion,  
6 through which a slider 45 disposed under the base plate 32A is  
7 reciprocatingly moved in the longitudinal direction along the  
8 slot 32a.

9 The slider 45 is roughly rectangular in configuration  
10 and has a U-shaped cross section. The slider 45 is rotatably  
11 connected at the side face thereof with a connecting rod 46 by  
12 a bolt and nut 47. Further, the connecting rod 46 is rotatably  
13 connected at the rear end thereof with the connecting rod  
14 connection section 26 of the hinge arm 23 through a ball joint  
15 48.

16 When the motor 41 in the power unit module 40 operates,  
17 the slider 45 travels backwardly along the base plate 32A to push  
18 backwardly the connecting rod connection section 26 of the hinge  
19 arm 23 through the connecting rod 46 and as a result the hinge  
20 arm 23 rotates around the pivot 22 outwardly through the hinge  
21 arm penetrating hole 23A. As a result, the rear gate 20 supported  
22 by the rear gate mounting bracket 25 swings in a direction of  
23 opening the opening 13. On the other hand, when the slider 45  
24 travels forwardly along the base plate 32A, the hinge arm 23  
25 rotates around the pivot 22 inwardly to swing the rear gate 20

1 in a direction closing the opening 13.

2 The mounting base 32 on which the power unit module  
3 40, the slider 45 and the like are disposed, is secured to roof  
4 members, rear rail 14, brace 15 and side rail 16, respectively  
5 so as to hold the base plate 32A horizontally.

6 The connecting section of the mounting base 32 and the  
7 rear rail 14 will be described by reference to Fig. 5 showing  
8 a cross section taken by the line I-I.

9 The rear rail 14 has a hollow cross section formed  
10 by an outer rear rail 14A extending in the widthwise direction  
11 of the vehicle and having a L-shaped cross section and an inner  
12 rear rail 14B disposed opposite to the outer rear rail 14A. The  
13 inner rear rail 14B is reinforced by a reinforcement 14C covering  
14 the upper surface of the inner rear rail 14B. The rear rail 14  
15 is connected at left and right ends thereof with the rear end  
16 of left and right side rails 16 and is connected at the upper  
17 surface of the outer rear rail 14A with the rear end of a roof  
18 panel 17, respectively.

19 Further, a plate-shaped rear bracket 34 is spot-welded  
20 to the under surface of the inner rear rail 14B, extending  
21 therefrom forwardly. The rear section of the base plate 32A of  
22 the mounting base 32 is mounted on the upper surface of the front  
23 end of the rear bracket 34 and detachably connected by a bolt  
24 14a and a nut 14b.

25 The mounting base 32 is connected at the middle section

09752564-010304  
1 thereof with the brace 15 through a first inner bracket 35 and  
2 a second inner bracket 36, respectively. The brace 15 is, as shown  
3 in Fig. 6, a belt like reinforcement member provided under the  
4 roof panel 17 across left and right side rails 16 (in the drawing,  
5 only left side is shown). The side rail 16 has a hollow cross  
6 section extending in the longitudinal direction of the vehicle  
7 and formed by L-shaped or C-shaped outer side rail 16A and inner  
8 side rail 16B reinforced by a reinforcement 16c.

9 The first inner bracket 35, as shown in Figs. 4 and 6,  
10 has plate-like configuration and mounting surfaces 35b, 35c are  
11 bent at the upper end of a connecting surface 35a of the first  
12 inner bracket 35 and project in the outer and inner directions,  
13 respectively so as to form a T-shaped cross section. These  
14 mounting surfaces 35b and 35c are connected to the under surface  
15 of the brace 15 by welding.

16 On the other hand, as shown in Fig. 4, the second inner  
17 bracket 36 having a L-shaped cross section includes a connecting  
18 surface 36a and a mounting surface 36b. The mounting surface 36b  
19 is connected with the base plate 32A of the mounting base 32.  
20 By connecting the connecting surface 36a with the connecting  
21 surface 35a of the first inner bracket 35 by means of bolts 15a  
22 and nuts 15b, the mounting base 32 can be detachably connected  
23 with the brace 15.

24 Describing the front portion of the mounting base 32,  
25 the mounting base 32 is connected with the side rail 16 through

09752564-010307  
1 an outer bracket 37. The outer bracket 37 is connected at the  
2 rear edge thereof with the front edge of the base plate 32A of  
3 the mounting base 32 and at the same time its outer edge extends  
4 in the forward direction along the side rail. Further, the outer  
5 bracket 37 forms a triangular configuration with a base lying  
6 along the front edge of the base plate 32A and has a reinforcement  
7 flange 37b bent upward along the oblique side of the triangle  
8 and a mounting flange 37c bent downward along the other base of  
9 the triangle.

10 The connecting section of the mounting base 32 and the  
11 side rail 16 is shown in Fig. 7. The mounting flange 37c of the  
12 outer bracket 37 is connected by a bolt 16a and a nut 16b with  
13 an inner side rail 16B of the side rail 16. That is, the front  
14 portion of the mounting base 32 is detachably connected with the  
15 side rail 16. Thus, an accommodation space for the power module  
16 unit 40 is formed at the corner enclosed by the rear rail 14 and  
17 the side rail 16 under the roof.

18 A gas stay apparatus 50 is disposed between the mounting  
19 base 32 and the side rail 16 at almost the same height as and  
20 approximately in parallel with the connecting rod 46 and has a  
21 gas spring 51 jointing the side rail 16 and the hinge arm 23.

22 *Sub* The gas spring 51 is rotatably connected at one end  
23 *997* thereof with a bracket 53 secured to the side rail 16 through  
24 a ball joint 54 and is also rotatably connected with at the other  
25 end thereof, that is, an end of a piston rod 51a, with the gas

Ad 1 stay/connection section 27 of the hinge arm 23 through a ball  
2 joint 56.

3 Accordingly, when a switch provided on an instrument  
4 panel is turned on to open the rear gate 20, the slider 45 is  
5 driven by the motor 41 to travel backward. Then, the connecting  
6 rod connection section 26 of the hinge arm 23 is pushed backward  
7 through the connecting rod 46 and the hinge arm 23 rotates about  
8 the pivot 22 together with the rear gate 20. As a result, the  
9 end of the piston rod 51a of the gas spring 51 rotates about the  
10 pivot 22 to draw a circle. The piston rod 51a is biased in the  
11 projecting direction by the pressure of sealed gas.

12 When the rear gate 20 is fully closed, the downward  
13 force due to the weight of the rear gate 20 is designed so as  
14 to be larger than the force pushing the rear gate 20 upward due  
15 to the biasing force of the gas spring 51.

16 Further, as shown in Fig. 10, when the rear gate 20  
17 starts to open from the fully closing position, a dead point where  
18 the weight of the rear gate 20 balances with the biasing force  
19 of the gas spring 51 is found. A self closing zone where the weight  
20 of the rear gate 20 is larger than the biasing force of the gas  
21 spring 51 and the rear gate closes without any operating force  
22 applied is formed between the fully closing position and the dead  
23 point. On the other hand, a self opening zone where the biasing  
24 force of the gas spring 51 is larger than the weight of the rear  
25 gate 20 is formed between the dead point and the fully opening

1 position.

2 Accordingly, since the power unit module 40 and the  
3 slider 45 which have relatively large weight and are subjected  
4 to the reaction force from the rear gate 20, is mounted on the  
5 mounting base 32 and the mounting base 32 is secured to the steady  
6 roof members such as the rear rail 14, the brace 15, the side  
7 rail and the like, the power unit module 40, the slider 45, the  
8 connecting rod 46 interlocking the slider 45 and the hinge arm  
9 23 can be supported in a stable condition.

10 Further, since the mounting base 32 is detachably  
11 connected with the rear rail 14, the brace 15 and the side rail  
12 16 by the bolts and nuts, it is possible first to attach the power  
13 unit module 40, the slider 45 and the like to the mounting base  
14 32 and then to mount this subassembly to the rear rail 14, the  
15 brace 15 and the side rail 16, thereby the installation work of  
16 the rear gate opening and closing apparatus 30 is simplified.  
17 As a result, the productivity at the production stage or the  
18 workability at the repairing stage is can be enhanced.

19 Further, since the gas spring 51 is longitudinally  
20 disposed at approximately the same height as and in parallel with  
21 the connecting rod 46, the opening and closing apparatus 30  
22 comprising the drive unit 31 and the gas stay apparatus 50 can  
23 be formed compactly within a limited vertical space. Further,  
24 since the opening and closing apparatus 30 is efficiently  
25 accommodated in a space enclosed by the rear rail 14, the side

1 rail 16 and the roof, the passenger compartment space can be  
2 utilized effectively.

3 Further, since the gas spring 51 is not disposed between  
4 the side edge 13a and the rear gate 20, the rear pillar, the rear  
5 gate 20 and the like can be freely styled and designed.

6 Fig. 8 shows a rear gate opening and closing mechanism  
7 according to a second embodiment. The power unit module 40  
8 includes the motor 41 described before, a clutch 42 and an encoder  
9 43. Further, an electronic control unit (hereinafter, referred  
10 to as ECU) 60 is disposed in the vehicle and makes an automatic  
11 opening and closing control of the rear gate 20.

12 The clutch 42 connects the motor 41 with the slider  
13 45 when it is energized and the connection is released when it  
14 is deenergized. When an operator wants to open or close the rear  
15 gate 20 manually, a handle switch 62 which will be described  
16 hereinafter is operated and the ECU 60 detects this to deenergize  
17 the clutch 42. When the clutch is deenergized, the motor 41 is  
18 disengaged with the slider 45 and the rear gate 20 can be operated  
19 to open or close manually. On the other hand, when the operator  
20 wants to open or close the rear gate 20 automatically, the clutch  
21 42 is energized to engage the motor 41 with the slider 45. As  
22 a result, the rear gate can be opened or closed automatically.

23 The encoder 43 provided in the power unit module 40  
24 detects the position of the slider 45 and outputs the positional  
25 signal to the ECU 60.

1 As shown in Fig. 9, the ECU 60 is connected with a  
2 warning buzzer 44, a latch switch 61, a handle switch 62, an  
3 operating switch 63 and an auto closure 65. The operating switch  
4 63 is provided with an opening switch (not shown), a closing switch  
5 (not shown) and a stop switch (not shown). When an operator  
6 operates these switches, an opening signal, a closing signal and  
7 a stop signal are outputted to the ECU 60, respectively. The handle  
8 switch 62 provided in an outer handle (not shown) for operating  
9 the rear gate 20 manually, is for detecting the operating  
10 condition of the outer handle.

11 The auto closure switch 65 is for holding or releasing  
12 a striker provided at the lower end of the rear gate 20 by actuating  
13 an electrically operated latch thereof.

14 The latch switch 61 acts as detecting whether or not  
15 the striker exists in a guide groove of the auto closure 65. When  
16 the latch switch 61 detects the striker, the latch rotates to  
17 engage the striker in an engaging groove of the latch.

18 The warning buzzer 44 raises warnings intermittently  
19 when the rear gate 20 is in an automatic opening or closing mode.  
20 The interval of intermittent warning is established so as to  
21 change according to the opening mode or closing mode.

22 Accordingly, the operator can recognize whether the  
23 rear gate 20 is opening or closing without seeing the movement  
24 of the rear gate. Further, the buzzer can warn surrounding persons  
25 of the moving rear gate 20. The warning buzzer 44 may be

1 accompanied by a hazard lamp and the like.

2 Signals from the operating switch 63, encoder 43,  
3 handle switch 62 and latch switch 61 are inputted to the ECU 60  
4 and the clutch 42, motor 41 and auto closure 65 are controlled  
5 by the output from the ECU 60 to automatically open or close the  
6 rear gate 20.

7 Hereinafter, the automatic opening and closing  
8 operation will be described. First, in case where the rear gate  
9 20 is fully closed, when the opening switch of the operating switch  
10 63 is operated, the latch of the auto closure 65 rotates in the  
11 opening direction to release the striker from the hold position.

12 When the striker is released, the rear gate 20 is pushed  
13 in the opening direction by the reaction force of weather strips  
14 and the like and the striker comes out of the guide groove. At  
15 this moment, the latch switch 61 detects the release of the  
16 striker.

17 Then, the ECU 60 receives a release signal from the  
18 latch switch 61 and energizes the clutch 42 to connect the motor  
19 41 with the slider 45. At the same time, the ECU 60 energizes  
20 the motor 41 and the motor 41 rotates in the forward (opening)  
21 direction.

22 When the motor 41 rotates in the forward direction,  
23 the slider 45 travels in the opening direction of the rear gate  
24 20, that is, in the backward direction, through the gear box.  
25 When the slider 45 travels in such a way, the rear gate 20 rotates

1 in the opening direction through the connecting rod 46 and hinge  
2 arm 23. The ECU 60 detects a position where the rear gate is based  
3 on signals from the encoder 43 and controls the driving force  
4 of the motor 41 according to the position of the rear gate 20.

5 For example, as shown in Fig. 10, when the rear gate  
6 20 is in the self closing zone as described before, the driving  
7 force of the motor 41 is controlled so as to assist the biasing  
8 force of the gas spring 51 in the opening direction of the rear  
9 gate 20. On the other hand, when the rear gate 20 is in the self  
10 opening zone, the driving force of the motor 41 is controlled  
11 so as to restrict the movement of the rear gate 20 in the opening  
12 direction.

13 Thus, when the rear gate 20 is in the self closing zone,  
14 the biasing force of the gas spring 51 is reduced and, when in  
15 the self opening zone, the rear gate 20 is prevented from rotating  
16 in the opening direction at a speed higher than a specified speed.  
17 Particularly, since the biasing force of the gas spring 51 tends  
18 to become large in accordance with an increase of outside  
19 temperature and as a result the opening speed of the rear gate  
20 tends to become high, the opening speed can be controlled to  
21 be constant.

22 When the encoder 43 detects the rear gate 20 fully  
23 opened, the opening motion is finished. In case where the output  
24 of the encoder 43 does not change in spite of driving the motor  
25 41, it is judged that the rotation of the rear gate 20 in the

1 opening direction is inhibited by an obstacle and the like,  
2 and the opening motion is stopped.

3 Further, when an operator operates the outer handle  
4 to stop the opening motion and an input signal is received from  
5 the handle switch 62, the opening motion stops. In order to stop  
6 the opening motion, the motor 41 stops its rotation. The operating  
7 switch 63, according to the input from the operating switch 63  
8 or the handle switch 62, selects condition of continuing the  
9 opening operation, condition of continuing the closing operation  
10 and condition of enabling the manual operation.

11 The above control is initialized when the rear gate  
12 20 is closed by the manual or automatic operation and comes into  
13 a fully closing condition. The ECU 60 sets the position of the  
14 rear gate to the fully closing position based on the detection  
15 signal of the latch switch 61.

16 Accordingly, in case where the rear gate 20 stops its  
17 motion on the way of opening or closing and as a result the encoder  
18 is unable to detect the current position of the rear gate 20,  
19 the position of the rear gate 20 can be initialized by once  
20 manually bringing the rear gate 20 into the fully closing  
21 condition.

22 On the other hand, in case where the rear gate 20 is  
23 in a fully opening condition, when the closing switch of the  
24 operating switch 63 is operated, the ECU 60 energizes the clutch  
25 42 to engage the motor 41 with the slider 45 and the motor 41

1 is driven in the closing direction.

2 When the motor 41 is driven in the closing direction,  
3 the slider 45 travels in the direction of closing the rear gate  
4 20, that is, in the forward direction through the gear box, and  
5 rotates the rear gate 20 in the closing direction through the  
6 connecting rod 46 and the hinge arm 23. The ECU 60 detects the  
7 position of the rear gate 20 based on a detection signal of the  
8 encoder 43 and controls the driving force of the motor 41 according  
9 to the position of the rear gate.

10 For example, when the rear gate 20 is in the self opening  
11 zone, the rear gate 20 is controlled against the biasing force  
12 of the gas spring 51 so as to rotate in the closing direction  
13 and when the rear gate 20 is in the self closing zone, the rear  
14 gate 20 is controlled so as to restrict the rotation in the closing  
15 direction. Through this control, the rear gate 20 can be prevented  
16 from rotating in the closing direction at a speed higher than  
17 established beforehand.

18 When the rear gate 20 rotates in the closing direction  
19 and the entrance of the striker into the guide groove is detected,  
20 the clutch 42 is deenergized and the engagement of the clutch  
21 42 is released. At the same time, the latch is rotated by the  
22 auto closure 65 and the striker is engaged with the engagement  
23 groove of the latch, thereby the rear gate 20 comes in a fully  
24 closing condition.

25 Thus, a series of the opening and closing motion through

09752564-010301  
TOP SECRET

1 the operating switch 63 finishes. With respect to the stop of  
2 closing operation due to an obstacle or by the operation of the  
3 outer handle and the initialization of the control, since these  
4 are the same as the above described controls from the fully closing  
5 condition to the fully opened condition, descriptions in more  
6 detail will be omitted.

7 Next, the automatic opening and closing motion by other  
8 operations than the operating switch 63 will be described.

9 For example, in case where the rear gate 20 is in a  
10 fully closing condition, an operator operates the outer handle  
11 to release the engagement between the latch and the striker. As  
12 a result, the rear gate can be opened manually.

13 The ECU 60 calculates the rotation speed in the opening  
14 direction of the rear gate 20 based on a detection signal of the  
15 encoder 43 and judges whether or not the speed is within an  
16 established speed range. When it is within a specified speed range,  
17 the motor 41 is controlled to rotate at a speed corresponding  
18 to the specified opening speed and then the clutch 42 is engaged.  
19 As a result, the rear gate 20 rotates automatically in the opening  
20 direction. On the other hand, when it is not within a specified  
21 speed range, the automatic opening motion of the rear gate 20  
22 stops.

23 Further, in case where the rear gate 20 is fully opened,  
24 when the operator rotates the rear gate 20 by hand in the closing  
25 direction, the ECU 60 calculates the traveling speed in the

1 closing direction of the rear gate 20 based on a detection signal  
2 from the encoder 43. Further, the ECU 60 judges whether or not  
3 the traveling speed is within a specified speed range. If it is  
4 within a specified speed, the motor 41 rotates in the closing  
5 direction at a speed corresponding to the traveling speed and  
6 the clutch 42 is engaged. The rear gate 20 rotates in the closing  
7 direction automatically. If it is not within a specified speed,  
8 the automatic closing motion stops.

9 Thus, since the rear gate 20 can be opened or closed  
10 without using the operating switch 63, it is convenient and easy  
11 to use, for example, baggage can be carried into or out of the  
12 compartment easily.

13 The present invention is not limited to the embodiment  
14 described above. For example, according to the embodiment of the  
15 present invention, the encoder 43 serves as detecting the fully  
16 opening or closing position of the rear gate 20 or the encounter  
17 of an obstacle during traveling of the rear gate, however  
18 alternatively, an electric current passing through the motor 41  
19 may be used.

20 That is, the fully opening or closing position or an  
21 obstacle during opening and closing operation may be detected  
22 based on an increase or decrease of electric current passing  
23 through an ampere detection circuit according to the load of the  
24 motor.

25 According to a rear gate automatic opening and closing

09752564-010304  
T06070-4955260

1 apparatus for a vehicle disclosed in the second embodiment, the  
2 clutch and actuator is controlled based on the operation of the  
3 operating means to automatically open or close the rear gate.  
4 At this moment, the traveling speed of the rear gate is calculated  
5 based on a detection signal of the encoder and the actuator is  
6 controlled so as to open or close at a specified speed.

7 Accordingly, the traveling speed of the rear gate can  
8 be controlled properly. Particularly, the rear gate opening speed  
9 tends to increase due to an increase of the biasing force according  
10 to outside temperature rise and the control means according to  
11 the present invention enables the rear gate to open irrespective  
12 of outside temperature at a constant speed.

13 Further, since the clutch is provided between the  
14 actuator and the rear gate, by disengaging the clutch the rear  
15 gate can be operated to open or close by hand.

16 While the presently preferred embodiments of the  
17 present invention have been shown and described, it is to be  
18 understood that these disclosures are for the purpose of  
19 illustration and that various changes and modifications may be  
20 made without departing from the scope of the invention as set  
21 forth in the appended claims.